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Climate of the Past Discussions

Interactive comment on "Holocene evolution of summer winds and marine productivity in the tropical Indian Ocean in response to insolation forcing: data-model comparison" *by* F. C. Bassinot et al.

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This paper compares published paleoceanography records of the Holocene summer monsoon from two regions with clever and insightful modeling studies, including a new model of foraminifer plankton sedimentation. Using equilibrium simulations for summer and winter for 0kyr, 6kyr, and 9kyr, the authors show the precession-driven changes in the monsoon winds, use the winds to drive an ecosystem model for 6kyr and 0kyr, and use the output from the ecosystem model to drive a model of foraminifer sedimentation. The results show the dramatic changes in this upwelling region, and reveal

model simulations consistent with paleocean data. Most important, they present model results that resolves an important controversy in Arabian Sea monsoon paleoceanography. They reveal the out-of phase character of upwelling off the tip of India (with respect to sites off Oman) as being attributable to the migration of the ITCZ (and zone of strongest summer monsoon winds) during the Holocene. According to this study, As the ITCZ and core of the winds shifts south from 9kyr to 0kyr, upwelling increases off the tip of India, while it decreases off Oman. Figure 8 is one of those memorable and iconic figures because of it successfully addresses the controversy and its potential resolution. Although the paper has some rough edges both in experimental design and presentation, I found the paper clear and easy to follow, and found the results to be useful and significant. While not a breakthrough paper, I believe this paper will be useful and of interest to many paleoceanographers. I look forward to learning more about the foraminifer model. In this ms the model is described as Lombard, et al., submitted and little information is provided about the model.

The authors present some additional insights regarding monsoon upwelling differences between Oman and S. India. One difference is the annual cycle of upwelling differs (its not a simple once-a-year monsoon maximum upwelling flux), the second is the comparison of the winter monsoon for both regions (often the winter is ignored). Finally, in Figure 8, upwelling velocity is plotted for 20 different model years, showing how large the year-to-year variability is.

Rough aspects of the experimental design reduce the overall impact of this paper. Unfortunately, I don't think these can be improved. One would like transient simulations from 9kyr to the present, but these models are only capable of equilibrium simulations (e.g., for 0kyr, 6 kyr, and 9kyr). Further, the PISCES ecosystem model was not run for 9kyr (therefore the foraminifer model cannot be run), so the final time series comparison (fig. 8) can only be made between upwelling velocity and foraminifer percent abundance (from sediments). The superior comparison would be between modeled and observed foraminifer abundance for all times. Nevertheless, this summary figure

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is compelling in showing that the out-of-phase time series of upwelling at the two locations matches the out-of-phase bulloides time series from sediments.

Another rough aspect is the substantial difference between the modeled and the observed wind fields, which propagates to large biases in the ecosystem model. I followed the author's appraisal that the results remain useful, but it is rough to use results that differ so much from observations. The authors are forthright about the discrepancies.

The most important improvement the authors could make is to more completely document the migration of the ITCZ. This is not trivial because the ITCZ is not obvious in plots showing only the Arabian Sea. I suggest either adding a large scale (half-hemisphere?) figure, or creating a table that documents the latitude of the ITCZ and its shift through time. Providing this evidence will support the authors attribution of change to ITCZ migration.

One other suggested improvement is to make the comparisons between times and locations easier for the reader to follow. I suggest breaking the information that appears in lines 416-421 (percentage changes) into a table.

Technical and minor corrections At the beginning of the abstract, introduce the problem and the approach to be used, and remove the details such as core names and latitude).

Lines 148 (and elsewhere) Refer the winds consistently by the direction from which the wind comes, and not the direction the wind blows to.

Lines 130. What does 'growth of height' mean?

Lines 307 and below. Any additional details on the foraminifer model that can be provided without scooping the other paper will strengthen this paper. At the least, describe the specific inputs to the model, and the outputs.

The figure 7 caption does not match the figure.

Figure 8. The upper panel needs additional description in the caption.

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